Applied Science

INCORPORATED WITH

TRANSACTIONS OF THE UNIVERSITY OF TORONTO ENGINEERING SOCIETY

Old Series Vol. 27 TORONTO, MAY, 1914 New Series Vol. IX. No. 1

THE MANUFACTURE OF STEEL TUBING

Illustrated from Mine to Finishing Operations

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This industry, as a whole, is illustrated for the first time by motion pictures and lantern slides this evening. That portion which deals with the mining operations, blast furnaces, mixer, steel works, blooming and slabbing mills and skelp mills is common to the manufacture of practically all steel products. The manufacture of welded tubes is shown in detail, and the seamless processes are taken up in outline by means of diagrammatic slides.

In consideration of the presence of the members of the Central Railway and Engineering Society, what follows will have special reference to the application of steel tubing to mechanical construction, particularly to locomotives.

The proportion of iron and steel tubing used in locomotive construction is so large that experience with the various materials of which this tubing is made in locomotive practice, forms by itself a good criterion of the value of such materials for general machine construction. Hence we might first consider locomotive tubes and the relation which has been found between the properties of the material and the mileage record of the engine.

Service and Laboratory Tests

We have, as you are aware, three classes of tubing for boiler work: lap weld charcoal iron, lap weld steel and seamless steel. The first of these has been able to hold its own until recently, in spite of the comparatively inferior physical properties, probably due to the impression that charcoal iron was better able to resist corrosive conditions and was easier to weld than most grades of steel. The numerous laboratory tests which have been made in researches on this subject, particularly during the last ten years, have not shown the difference expected under natural conditions of corrosion; however, these tests were not considered entirely satis-

factory by practical men. Service tests were started by a number of the leading railroads, about the same time as these laboratory investigations and there is now available plenty of data from both sources. Most of these practical service tests were made by applying charcoal-iron and steel tubes, side by side, in the same boiler. When conditions developed which made it necessary to remove the tubes, they were cleaned and inspected, the corrosion being judged usually by the number of tubes of each set which had to be discarded, and the relative depth of pitting. Table 1 contains several recent examples of such investigations, typical of tests which have been run on many roads.

Tubes for Corrosive Conditions

When it comes to a choice of tubes to withstand corrosive conditions, we usually recommend "National" lap-weld steel tubes, which have the advantage of a patented process of roll-knobbling, that the steel receives in being worked down from the bloom to the plate. By this kneading operation the metal receives considerably more mechanical work laterally, is made uniformly dense, and other conditions being equal, is more resistant to corrosion.

Advance in Modern Steel Tubes

The increased use of steel tubes in later years, is probably due to a recognition of the physical superiority of the material, together with a better understanding of the causes of corrosion. A special grade of open hearth steel has been developed which is now used in the manufacture of both lap-weld and seamless tubes. Particular attention is given to the welding quality of this steel, and its power to withstand manipulation in setting and reworking. There is now practically no loss in installing modern steel tubes, either lap weld or seamless, and as they will withstand, without cracking, so much more expansion than the old charcoal iron, it is not a matter of much consequences; if the flue-sheet hole happens to be worn a little large. The sectional expander may be used in setting, without fear of splitting the tube, and a good shoulder obtained behind the sheet and a strong bead in front, thus holding the tube firmly in the flue sheet. The sectional expander, or if preferred, the roller expander, may be used on this class of steel tubes until the tube is too thin for further service without injury to the metal. The steel being stiffer than the iron, requires less attention on account of leaking while in service, which means, of course, considerably less cost for maintenance. The steel beads are stronger than charcoal iron and much better able to resist the various stresses incident to modern service. In order to be sure that each lap-weld tube is up to the required standard, a machine was designed to turn a flange on the crop ends cut from each tube. This testing operation, as carried out every day in the mills, is illustrated in motion pictures at this meeting.

Wearing Quality in Flue Sheet

With respect to durability in the flue sheet, there is abundant evidence on record to show that the mileage with modern "National" steel tubes is considerably greater under the same conditions than with charcoal iron. In table II, we give a few comparative figures from various railroads indicated by letter. One of the most remarkable examples of unbroken service is that illustrated by the Lehigh Valley Railroad passenger engine No. 2479, which in June, 1913, completed 245,675 miles in 28 months, pulling an average 450-ton train, on one set of lap-welded steel tubes.

(Details regarding this engine can, no doubt, be obtained by addressing the superintendent of motive power.) This brief summary will suffice to explain why the leading American tube interest has discontinued the manufacture of charcoal iron tubes.

Safe Ending

With a little attention and some experience, the welding on of safe ends, steel to steel, should cause no particular difficulty. Much less is heard of difficulty in this connection to-day and there is certainly less possibility for trouble when the practice is to use steel exclusively, as is now the case in a number of shops, rather than to switch from iron to steel alternately; for the same reason the manufacture of one grade of steel for all tubes has also helped to bring about a more favorable condition.

In safe ending in the usual way it is best to heat the body tube to a bright orange color (about 1750° F) for expanding, and allow it to cool to at least a blue heat before reheating for welding. Precaution should be taken not to overheat the metal near the weld, which is more liable to occur if there is much difference in gauge between the body tube and safe end.

Electric Butt Welding

The recent application of electric butt welding to safe ending is worthy of careful consideration. It has an important advantage in that the metal away from the weld cannot readily become overheated. It appears to be easy to control, is economical and should give a continuous, fine grained structure through the weld. Some tests recently made in our laboratory show an electric butt weld to have ninety per cent. of the strength of the metal.

About ninety per cent of the locomotives in America are now equipped with steel safe ends. Some still adhere to the use of charcoal iron body tubes carrying steel safe ends. The reason for this apparent inconsistency is not plain.

Seamless Tubes in Machine Design

An increasing amount of seamless tubing is being used for mechanical purposes. The variety of shapes and physical properties

which can be obtained in tubular sections gives this product special advantages for many purposes. A large proportion of the tonnage of mechanical seamless tubing made in America goes into automobile parts, bushings, roller and ball bearing, hollow axles, gas containers, working barrels, drill pipe, etc., etc. We have compiled a list showing 300 separate uses.

A few typical examples of the application of seamless tubing to machine design are illustrated at the end of this paper, these showing bending, expanding, swaging, tapering, deforming, closing of ends, upsetting and various combinations of these operations.

Table III gives in brief form the physical properties of the standard steels used in the manufacture of Shelby Seamless Steel Tubing, with standard heat treatment. The low carbon grade is particularly adapted to case hardening, and is frequently used in tubular forms for this purpose.

American vs. German Practice

The manufacture of tubes and pipe in the United States differs from the German practice, principally in that the welding process has been further developed and predominates in United States; whereas in Germany the manufacture of seamless tubes has been so simplified and cheapened as to generally fill the uses to which welded pipe is more generally applied in this country. In Germany this is accomplished by the use of small cast round ingots which are fabricated directly into tubes without the intermediate blooming mill and bar mill rolling operations. Of course the finished product is comparatively inferior in quality and cannot be compared with the tubes made from the rolled round or cupped plate, but may be sufficiently sound for many purposes. In Germany, as here, solid rolled rounds made of selected steel are used for the better class of tubing, and in special cases the solid round is drilled through cold and then rolled down over mandrils in the usual manner. There is naturally a wide difference in price in German seamless tubes, depending on the purchasers' specifications, which determines the process by which the tubes are to be made and how rigid an inspection shall be given.

Investigation has shown that so far as the quality of steel itself is concerned, our methods of manufacture give as good a quality of metal for seamless tubes as the best quality made in Germany. The fabrication of the steel puts a great strain on the metal and more or less loss is expected, principally on account of cracks and light surface defects. Most of these are quite insignificant in depth and do not affect the strength of the tube perceptibly, but, as they tend to spoil the appearance of the highly finished surface, a rigid inspection is employed to cull out tubes showing such defects. The surface defects caused in the first operations of manufacture are removed, as far as practicable, with pneumatic chisels, before the blank is worked any further. At present in the United States,

practically all seamless steel tubing is made from solid rounds rolled from the blooms, the principle exception being seamless containers which are made by the plate and cup process.

Significance of Inspection

If any difference in quality or finish is noticed between American and German seamless tubes it is probably due to the system of inspection which depends on the specifications and the use for which the tubes are made. For instance, it would be waste to put more than fifty cents per ton on inspection of a lot of tubes for one purpose, whereas the same lot might require several dollars per ton to fit it for other conditions. Hence it is most important in ordering seamless tubes to specify clearly for what they are to be used, and as far as possible, adhere to standard specifications.

In looking at the relative advance in the iron and steel industry in America and Germany, it would be well to consider what industrial research has had to do with efficiency.

The details of the industry in each of these countries have been worked out so far in a way best suited to their respective conditions. The problems in America have been handled, for the most part by men who have depended more on practical than high technical training with the object of achieving immediate results to satisfy the pressing demands of the times.

Our general public have a confused or imperfect idea of the significance of industrial research to the ultimate development of our industries.

In Germany, on the contrary, industrial research has become a highly specialized branch of their industries and receives the popular recognition and support so necessary to the largest success.

It seems safe to predict that with the dispelling of public indifference to this kind of research and the training of men along sound scientific lines who will combine in their work energy and audacity with a strong sense of initiative, even Germany must soon yield to America in the worth and volume of achievements in this field.

Value of Standard Specifications

In closing it might be of interest to say a word briefly on the question of specification for steel tubes. Several years ago there were in use in America twenty or thirty specifications for locomotive boiler tubes, all differing slightly but sufficiently to require special attention to each individual order going through the mill. This, of course, increased the cost to the manufacturer and consumer, with no corresponding benefit in the quality of the product.

The author endeavored to arouse interest in this matter in a paper before the American Society for Testing Materials, June 27, 1911, after which a committee was appointed, consisting in the majority of railroad engineers through whose work the first standard American tube specification was adopted in 1912. In the following

year this committee, in conjunction with another of the American Master Mechanics' Association, who had been laboring along the same lines, adopted a combined specification for tubes in June, 1913, which is reprinted on another page for reference. (See below).

Whatever your personal views may be on the question of specifications, this one should receive your careful study and consideration before deciding to write any other. It was only adopted after years of discussion and investigation on every item by engineers representing large manufacturers and users of tubes, and their recommendations were accepted without change by two of the largest engineering societies of the country. The National Tube Company also have a number of specifications for special products, such as steel shipping containers for compressed gases and liquids, trolley poles, signal pipe, etc. Whenever standard specifications are agreed upon, it has been our practice to accept these as the standard of manufacture.

Standard Specifications for Lap-welded and Seamless Steel Boiler Tubes, Safe Ends and Arch Tubes (including superheater tubes) as revised jointly, 1913, by the American Railway Master Mechanics' Association and the American Society for Testing Materials

I. Manufacture

1. Process. The steel shall be made by the open-hearth process.

II. Chemical Properties and Tests

2. Chemical composition. The steel shall conform to the following requirements as to chemical composition:

Carbon	0.08—0.18 per cent.
Manganese	0.30—0.50 per cent.
Phosphorus	not over 0.04 per cent.
Sulphur	not over 0.045 per cent.

3. Chemical Analyses. (a) Analyses of two tubes in each lot of 250 or less may be made by the purchaser, which shall conform to the requirements specified in Section 2. Drillings for analyses shall be taken from several points around each tube.

(b) If the analyses of only one tube does not conform to the requirements specified, analyses of two additional tubes from the same lot shall be made, each of which shall conform to the requirements specified.

III. Physical Properties and Tests

4. Flange Tests. (a) A test specimen not less than 4 inches in length shall have a flange turned over at right angles to the body of the tubes without showing cracks or flaws. The flange as measured from the outside of the tube, shall be three-eighth inch wide for tubes 2½ inches or less outside diameter, and ½ inch wide for tubes larger than 2½ inches outside diameter.

(b) In making the flange test, the flaring tool and die block as shown should be used.

5. Flattening Tests. A test specimen 4 inches in length shall stand hammering flat until the inside walls are in contact, without cracking at the edges or elsewhere. For lap-welded tubes, care should be taken that the weld is not located at the point of maximum bending.

6. Crush Tests. A test specimen 2½ inches in length shall stand crushing longitudinally until the outside folds of metal are in contact, without showing cracks or flaws.

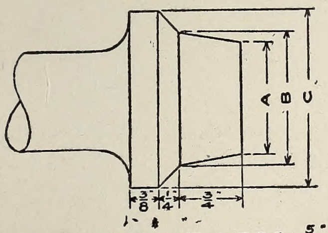
7. Hydraulic Tests. Tubes under 5 inches in diameter shall stand an internal hydraulic pressure of 1,000 pounds per square inch, and tubes 5 inches in diameter or over an internal hydraulic pressure of 800 pounds per square inch.

8. Test Specimens. (a) Test specimens shall consist of sections cut from tubes selected by the inspector representing the purchaser from the lot offered for shipment. They shall be smooth on the ends and free from burrs.

(b) All specimens shall be tested cold.

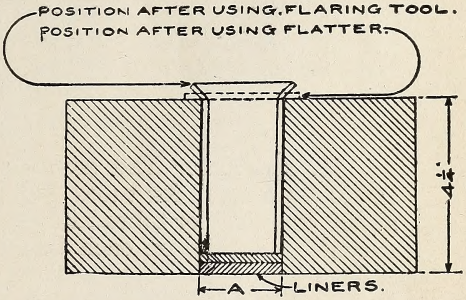
9. Number of Tests. One flange, one flattening and one crush test shall be made from each of two tubes in each lot of 250 or less. Each tube shall be subjected to the hydraulic test.

FLARING TOOL.



A. O.S DIA. OF FLUE LESS 5/8"
B. " " " " " 3/8"
C. " " " " PLUS 3/16"

DIE BLOCK.



A. O S DIA OF FLUE PLUS 1/32"

10. Retests. If the results of the physical tests of only one tube from any lot do not conform to the requirements specified in Sections 4, 5, or 6, retests of two additional tubes from the same lot shall be made, each of which shall conform to the requirements specified.

IV. Standard Weights

11. Standard Weights. The standard weights for tubes of various outside diameters and thicknesses are as follows:

Weight in Pounds Per Foot in Length

Thickness		Outside Diameter in Inches												
In.	Nearest B. W. G.	1¾	2	2¼	2½	3	* 3½	* 4	* 4½	* 5	* 5¼	* 5⅜	* 5½	* 6
0.095	13	1.68	1.93	2.19	2.44	....	....	....	....	....	....	....	....	....
0.110	12	1.93	2.22	2.51	2.81	3.40	....	....	....	....	....	....	....	....
0.125	11	2.17	2.50	2.84	3.17	3.84	4.51	....	....	....	....	....	....	....
0.135	10	2.33	2.69	3.05	3.41	4.13	4.85	5.57	....	....	....	....	....	....
0.150	9	2.56	2.96	3.36	3.76	4.57	5.37	6.17	6.97	7.77	8.17	8.37	8.57	9.37
0.165	8	....	....	....	4.11	5.00	5.88	6.76	7.64	8.52	8.96	9.18	9.40	10.28
0.180	7	....	....	....	4.46	5.42	6.38	7.34	8.30	9.27	9.75	9.99	10.23	11.19

*Note. It is regular practice of National Tube Co. to furnish for locomotive purposes sizes larger than 3″ O.D. in Seamless only.

12. Permissible Variations. The weight of the tubes shall not vary more than 5 per cent. from that specified in Section 11.

V. Workmanship and Finish

13. Workmanship. The finished tubes shall be circular within 0.02 inch, and the mean outside diameter shall not vary more than 0.015 inch from the size ordered. The thickness at any point shall not vary more than 10 per cent. from that specified. The length shall not be less, but may be 0.125 inch more than that ordered.

14. Finish. The finished tubes shall be free from injurious defects and shall have a workmanlike finish. They shall be free from kinks, bends and buckles.

VI. Marking

15. Marking. The name of the manufacturer and "Tested at 1,000 pounds" for tubes under 5 inches in diameter, or "Tested at 800 pounds," for tubes 5 inches in diameter or over, shall be legibly stenciled in white on each tube.

VII. Inspection and Rejection

16. Inspection. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the tubes ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the tubes are being furnished in accordance with these specifications. All tests (except check analyses) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and are to be so conducted as not to interfere unnecessarily with the operation of the works.

17. Rejection. (a) Tubes when inserted in the boiler shall

stand expanding and beading without showing cracks or flaws, or opening at the weld. Tubes which fail in this manner will be rejected and the manufacturer shall be notified.

(b) Unless otherwise specified, any rejection based on tests made in accordance with Section 3, shall be reported within five working days from the receipt of samples.

18. Rehearing. Samples tested in accordance with Section 3, which represents rejected tubes, shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for rehearing within that time.

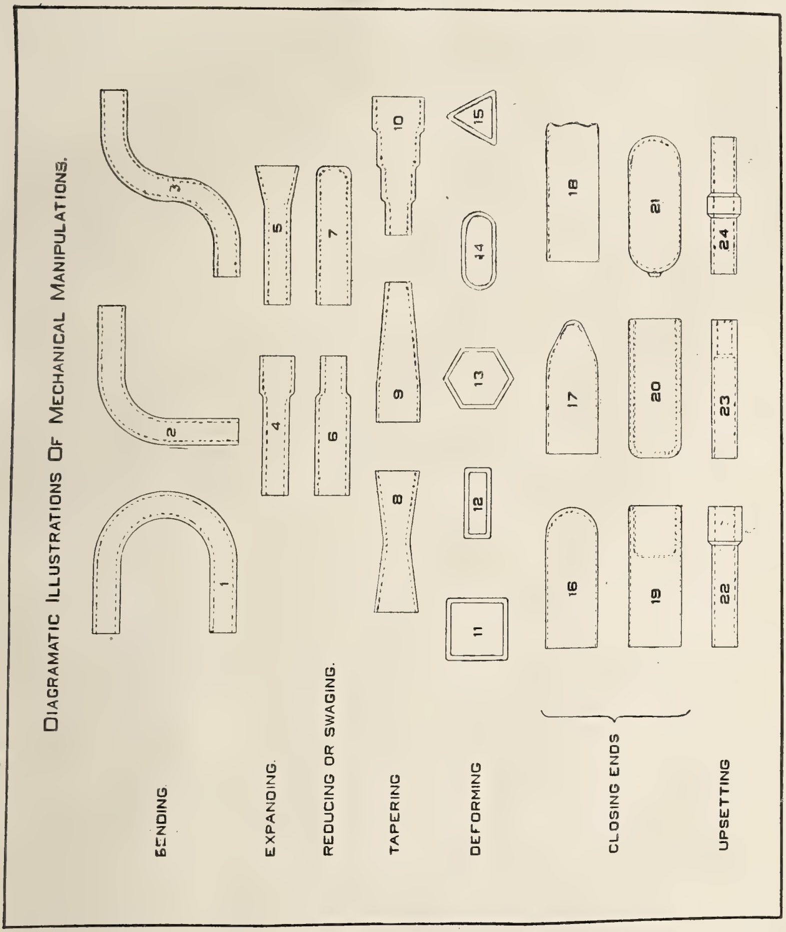


TABLE NO. 1

SERVICE CORROSION COMPARISONS

Railroad	Material Installed	Water Conditions	Length of Service	No. Discarded Steel	No. Discarded Iron	Cause of Rejection	Remarks
A	Charcoal-iron and lap-weld steel tubes in opposite sides of same engine.	Not stated	14 months	14 out of 176	49 out of 176	Pitting	
B	Tests made on three engines using half-sets of lap-weld steel and charcoal-iron tubes on each engine.	Bad	Three years (3 re-settings) Test continued	None	None		Steel tubes are in as good condition as iron. Tubes still in service.
C	Charcoal-iron and lap-weld steel.	Very bad	60,000 miles	25	75	Pitting	Engines in which iron and steel tubes were used, were in same service under same conditions.
D	Tests made on one engine, using lap-weld steel tubes on right side and charcoal-iron on left side.	Bad	11 months (Test continued)	3	6	Pitting	Tubes removed and examined after 11 months. All put back in boiler except 9 which were discarded.
H	Ingot iron and lap-weld steel tubes.	Bad	Iron—15,000 miles Steel—30,000 miles	3%	All Scrapped	Pitting	
I	Swedish iron and lap-weld steel in opposite sides of same engine.	Very bad	14 months (When examined)	None	All scrapp'd (one at end of 8 months)	Pitting	They report that 18 to 24 months' service is obtained from steel; best service from charcoal-iron was 12 to 14 months.
E	See "Remarks"	Extremely Bad	—See Remarks—				Now using lap-weld steel tubes on this division and obtain 25% more mileage and have less pitting than with charcoal-iron.

TABLE No. II.

MILEAGE—FLUE SHEET PRACTICE

Railroad	Mileage: Steel	Mileage: Iron	Water conditions	Remarks
A	101,000 (One engine)	50,000—60,000 Was considered good	Not stated	Test made on one engine equipped with lap-weld steel tubes under same conditions as the charcoal-iron previously used.
C	95,000 (Average)	46,000 (Average)	Bad	Engines equipped with lap-weld steel tubes tested in comparison with engines equipped with charcoal-iron tubes under same conditions.
B	80,500 (Average)	40,000 (Average)	Probably most severe in country	Tests made on engines equipped with lap-weld steel tubes under same conditions as the charcoal-iron previously used.
F	70,000 to 75,000 100,000 to 125,000*	Freight 20,000 to 25,000 Passenger 40,000 to 50,000	Not stated	About three years ago the use of charcoal-iron tubes on this railroad was abandoned in favor of steel tubes after comparative tests on these two materials.
G	78,000 (One engine)	40,000—50,000 (Average)	Not stated	Tests made on engine equipped with lap-weld steel tubes under same conditions as the charcoal-iron previously used. Tubes still good and in service.
H	Test on engine equipped with Swedish iron on one side and Shelby seamless tubes on the other side of same engine		Not stated	After 13 months engine was shopped. Nearly all beads on Swedish iron tubes were in bad condition; those on Shelby seamless tubes were apparently as good as ever.

*One engine on this road in fast passenger service equipped with lap-weld steel tubes made 245,675 miles before the tubes were removed. This exceptional case is probably the largest tube-mileage ever made in America. Full data as to this run is given on page 2.

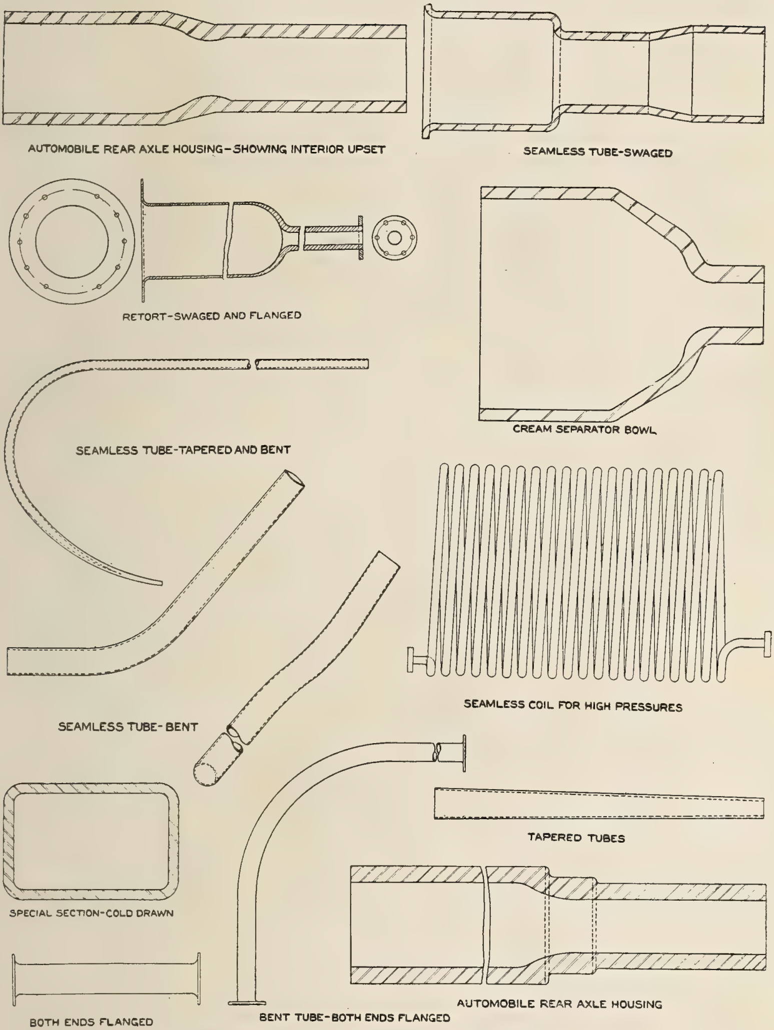
TABLE No. III.

PROCESS OF MANUFACTURE

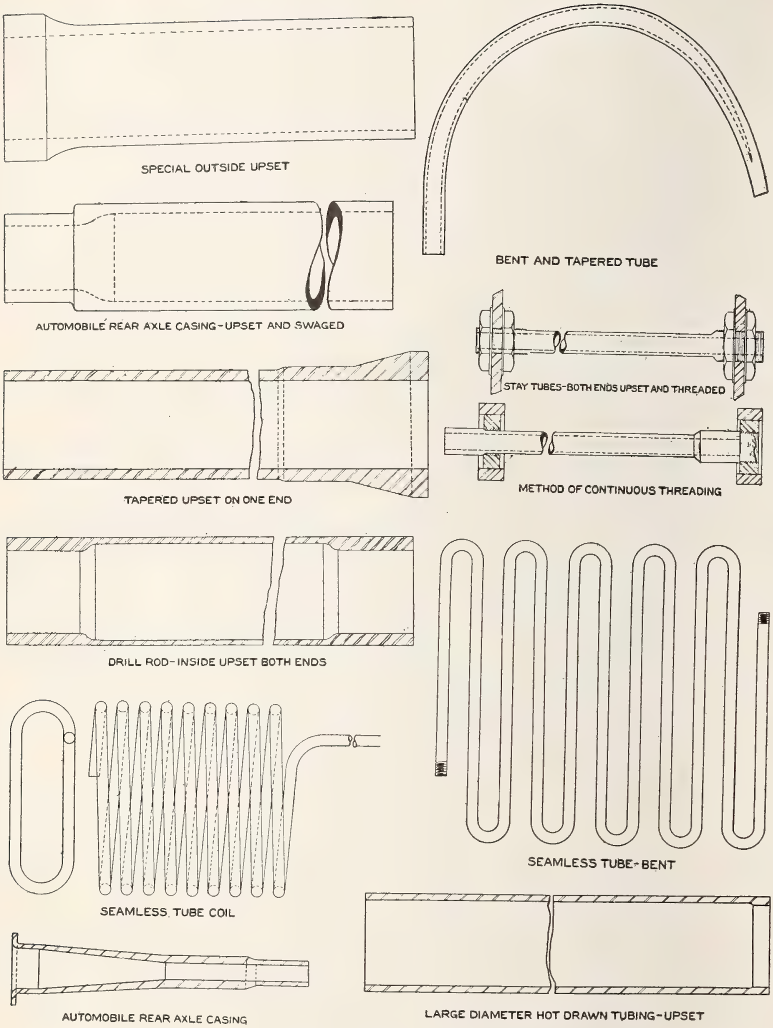
- WELDED
  - BUTT
  - LAP
  - MATERIAL USED: WROT IRON, BESSEMER AND OPEN HEARTH STEELS OF EASILY WELDABLE QUALITY
- SEAMLESS
  - ROTARY PIERCING.
  - PUNCHING.
  - HOLLOW CAST BILLETS.
  - PLATE CUPPING PROCESS.
  - MATERIAL USED: ALL GRADES OF OPEN HEARTH STEEL OF LOW MEDIUM AND HIGH CARBON. ALSO VARIOUS GRADES OF DIFFERENT ALLOY STEELS. IRON CANNOT BE USED, AND BESSEMER STEEL WITH ONLY INDIFFERENT SUCCESS.

GRADES		CHEMICAL ANALYSIS S	P	MN	C	NI	ELASTIC LIMIT IN LBS PER SQ.IN.	ULTIMATE STRENGTH IN LBS PER SQ.IN.	% ELONGATION IN 2 IN.	% ELONGATION IN 8 IN.	% CONTRACTION	HEAT TREATMENT
BESS.	AVERAGE	.045	.100	.30	.07		37000	57000		22	50	FINISHED HOT
O. H.	AVERAGE	.035	.030	.38	.10		32000	52000		25	55	FINISHED HOT
PUDDLED IRON	AVERAGE	.030	.200	TR	TR		27000	45000		13	30	FINISHED HOT
.17 CARBON	AVERAGE	.035	.030	.50	.17		40000	57000		30	50	FINISHED HOT
.17 CARBON COLD DRAWN	MAX.	.040	.030	.60	.19		70000	80000	18	7	30	NOT ANNEALED
	MIN.	.015	.010	.40	.14		55000	65000	12	3	20	
							65000	75000	25	16	45	FINISH ANNEALED
							50000	60000	18	10	35	
							48000	65000	60	28	60	MEDIUM ANNEALED
							35000	52000	50	22	50	
							35000	55000	65	33	62	SOFT ANNEALED
							27000	47000	55	28	52	
.35 CARBON COLD DRAWN	MAX.	.040	.030	.60	.40		90000	100000	15		18	NOT ANNEALED
	MIN.	.015	.010	.40	.30		75000	85000	10		12	
							85000	95000	30	18	32	FINISH ANNEALED
							70000	80000	20	12	25	
							65000	80000	45	30	42	MEDIUM ANNEALED
							50000	65000	35	20	35	
$3\frac{1}{2}$% NICKEL COLD DRAWN	MAX.	.040	.030	.60	.30	4.00	100000	110000	18		32	NOT ANNEALED
	MIN.	.015	.010	.40	.20	3.00	85000	95000	10		22	
							90000	105000	25		35	FINISH ANNEALED
							75000	85000	15		25	
							60000	85000	50	28	50	MEDIUM ANNEALED
							45000	70000	40	20	45	
Cr 1.00%	MAX	.040	.030	.60	.40		120000	155,000	30		55	900°C-Water.
20% V.	MIN	.015	.010	.40	.30		100,000	125,000	15		40	600°C-Air.

Torpedo Tubes
Submarine Air Flasks



Various manipulations of Shelby Seamless Steel Tubing



Various manipulations of Shelby Seamless Steel Tubing

CLAY AND SHALE DEPOSITS OF NEW BRUNSWICK

J. Keele, B.A.Sc., '93

The Geological Survey Branch of the Department of Mines, Ottawa, has just published a report by Mr. J. Keele, B.A.Sc., '93, on the clay and shale deposits of New Brunswick, covering the work done in that province by the Geological Survey during 1911 and 1912. Practically all the field examinations and the greater part of the laboratory work was done by Mr. Keele, he doing the laboratory work in the laboratories of the Mining building, University of Toronto.

The object of the work was to investigate the clay or shale deposits of sufficient extent to be of economic value, and which would be useful to the manufacturer of burned clay wares, for structural or other purposes. Oil-bearing shales are not included in the report, as it is impossible to mould such material into shape, and afterwards burn it so that it will retain its shape intact.

The work on clays and shales involves (1) The description of their mode of occurrence and of the areas underlain by them. (2) The sampling of the deposits in the field. (3) The laboratory work to determine their industrial value.

The laboratory work includes those physical tests which give the clay worker the most information regarding the quality of the clay, viz., tensile, working, shrinkage, burning and porosity tests. Chemical analyses were not made for this report as they are generally regarded by ceramists as being useless for foretelling the working and burning properties of a clay.

We make the following extracts from a chapter which is devoted to the present extent of the clay industry in New Brunswick.

Up to the present time the clay deposits of New Brunswick have only been developed to a very limited extent.

Wooden construction prevails, to the exclusion of almost all other kinds, except in the business portions of the cities and towns, because lumber has hitherto been plentiful and cheap in this Province.

The danger from extensive fires is always present when wooden construction is so freely used in closely built communities. This was evident in the total destruction of the town of Campbellton by fire during the summer of 1910. Since then, the demand for structural clay wares is increasing, but they are not yet used as largely as they might be, because everything except common brick has to be imported.

New Brunswick possesses in its Carboniferous rocks, certain shale beds, adapted for making those higher grades of clay wares which cannot be produced in the Provinces of Quebec or Ontario, where these raw materials are absent. Clayworkers will probably find it to their advantage to locate works for the production of materials, not only for home consumption, but also for export.

Proximity to markets, although desirable, is not so essential to manufacturers of the higher grades of clay wares, such as face bricks, paving bricks, sewerpipe, electrical conduits, fireproofing,

etc., as these materials are frequently transported for long distances. A plant equipped for a large output of common brick can only be maintained close to cities, where the demand for them is constant during the greater part of the year. These plants frequently represent a considerable expenditure of capital, being furnished with artificial driers, continuous kilns, and machinery driven by steam or electric power. The surface clays can be worked in a primitive manner, with a small outlay of capital, to suit the demands of small towns or rural communities. Such plants are able to maintain their position, because the price of common brick would not pay the cost of carriage from large centres where their manufacture is carried on more scientifically.

When the need for underdraining the cultivated areas in the Province becomes more generally known, these clays will have a much wider application. Drain tile can be made from any of the surface clays mentioned in this report. Tile are made from stiff mud, usually by an auger machine having a circular die, although different styles of plunger machines and also hand presses are used in their manufacture. They are made in sizes varying in diameter from 2 inches to 3 feet. Any means of drying and burning may be used with the smaller sizes, but the larger sizes require considerable care to prevent cracking. Contrary to the popular notion, it is not necessary for drain tile to be porous, so that they should be hard burned. Besides sufficient hardness, the important requirements for drain tile are straightness, uniformity of diameter, and smoothness of ends.

The only pottery in operation in the Province is located at St. John, on Loch Lomond Road. It is owned by J. W. Foley and Company, who manufacture butter crocks, teapots, jars, and flower pots. Most of the raw material is imported from the State of New Jersey.

The following details concerning the clay-working industry of the present time in New Brunswick are briefly given.

Fredericton.—M. Ryan and Son are the only brick manufacturers at this city. The material used is a surface clay, of the estuarine type, somewhat similar in character to that worked in the Annapolis, and Shubenacadie valleys of Nova Scotia. The clay is moulded in a soft mud machine, without any preliminary pugging, but nevertheless makes a good grade of brick. The freshly moulded bricks are hacked out on the ground to dry in the air, but since the writer's visit, Mr. Ryan has installed a steam drier. Burning is done in a patent double chambered downdraft kiln, each half having a capacity of 90,000 bricks. The brick settles 12 inches in 31 courses during the burning.

St. John.—Two brickyards are in operation in the vicinity of this city. The clays used are all similar, being evidently remnants of marine or estuarine deposits laid down at a slight elevation above present sea-level. The clays are smooth and plastic, and free from pebbles. Any pebbles found in the finished bricks have probably come from gravels overlying the clays.

The brickyard of Mr. John Lee is located on Courtney bay at the Little river. The material used here is a tough, reddish brown clay and worked to a depth of 6 or 7 feet below the surface. The brick clay rests on a very hummocky boulder drift, which crops out in a few places in the bottom of the pit. The clay, after being broken down from the bank, is dumped into soak pits, along with some sand, and kept there for a day or so before going to the machine. Sand moulded or soft mud bricks, some re-pressed bricks for facing buildings, and field drain tile are manufactured. The freshly moulded bricks are placed on covered pallet racks and air dried. There are two downdraft kilns, two updraft case kilns, and one scove kiln. The output is 25,000 bricks per day during the season, which are mostly sold in St. John.

St. Stephen.—There are two brick yards in operation near this town, making soft mud brick and drain tile. The material used is taken from a terrace of marine clay which occurs along the valley of the St. Croix river.

Mr. John Laming has made bricks here during the last 31 years. He uses a small stiff mud machine for making wire cut brick for facing, and for drain tile. He also makes soft mud bricks, which form the greater part of his output. The demand for drain tile is intermittent, these are only made to order, and not stocked. The principal object of interest is the tiles with which the building is roofed. These tiles were made by Mr. Laming, 22 years ago, from the clay in his own pit. These tiles are S shaped, and although not hard burned, are still quite intact for the most part.

Sussex.—The brickyard operated by Mr. John Heffer is situated a few miles northwest of Sussex. The material used is a stiff, reddish clay, from 3 to 10 feet in thickness, overlying boulder clay. A stiff mud machine driven by horse-power is used. The bricks are hacked out on the open ground to dry, and afterwards burned in a scove kiln.

The burned bricks contain some scattered, small pebbles and clay lumps, showing the need of passing the clay through rolls, or through a long pug mill, to prepare the clay for the machine. As the clay is becoming too thin for working at this locality, the plant will shortly be moved to a fresh clay deposit in the neighborhood.

Moncton.—The brickworks are located at Lewisville, 2 miles from Moncton. The material made is a glacial clay situated almost at tide level, and underlain by boulder clay. The maximum depth of the clay is 7 feet. This plant is equipped with a stiff mud machine, and steam driers. The burning is done in scove kilns. The brick clay also occurs at various points around the city of Moncton, but is worked only at this locality at present.

Chatham.—There are two brick plants in the neighborhood of Chatham, owned by the W. S. Loggie Company. The plant at Nappan river uses a stratified, reddish clay, about 12 feet deep, lying

on bed-rock, to which is added about 10 per cent. of sand. Sand moulded bricks only are made; they are dried on pallet rocks, and burned in scove kilns. The bricks are set 36 courses high in the kiln, and the fuel used is dry spruce and tamarack. The output is hauled in wagons to the railway, and shipped principally to Campbellton. The working season lasts from the middle of May to December. An excellent deep red, hard, building brick is produced at these works.

The plant at Nelson is worked in a similar manner, and produces common brick of a quality very much like those at Nappan. This plant is better situated for transportation, as the bricks have only to be hauled over the bridge across the Miramichi river, to the railway station on the north bank.

A NEW FIELD FOR GRADUATES IN MECHANICAL ENGINEERING

H. T. Routly, '06

During the last few years a new and very important field has been developing for the graduates in mechanical engineering—a field at present very much neglected by them. It is modern highway construction, which must not be confused with highway engineering, of which it is the fufillment or complement. The latter has always demanded and will continue to demand the best services of the civil engineer.

In the good old days when the famous Roman roads were being constructed there was small demand for the mechanical engineer. How the layman likes to tells us that we cannot build such roads now, little understanding why, or what the result would be if we did. It was not engines they used then but slaves, and no technical knowledge was required in the roads department save that pertaining to location and design of the roads and to the choice and arrangement of the materials of their construction, all such matters being then, as now, within the range of practise of the civil engineer whether he be attached to a military or to a municipal organization. And so well was his work done then that all down through the ages since, where intelligence has directed highway affairs, a civil engineer has been placed in command. He has had a practical monopoly of the technical side of all highway work and ably and devotedly has he applied himself to his duty. During the last decade especially the advent of the automobile has added tremendously to the problems and difficulties of the roadway engineer and the demand for the services of the experienced and capable has increased much faster than it could be supplied. For location, design, and general superintendence he will ever be in demand and without him we could have no good roads.

But while tremendous changes in design and materials of construction have taken place in recent years, there have been even greater changes in the manner of actually carrying out the plans

and designs of the engineer, all these changes being coincident and interdependent on each other.

Self-propelled road rollers have revolutionized our construction methods. As road building received a great impetus and a remarkable development associated with military movements and by means of unlimited cheap slave labor in the time of the Roman Empire, so now it is receiving a hundred-fold greater expansion and development associated with the demand for rapid tranpsortation and by means of costly though cheap labor saving machinery. The slave-driver with his horde of humans has given place to the mechanical engineer with his battery of engines and machines of wonderful variety and usefulness.

And now, once a system of roads has been located, designed and laid out by the civil engineer his work is practically over—except for passing the estimates of work done. The business of actual road construction is a question of machinery in three phases: (1) selection and purchase, (2) operation and care (3) maintenance and repair. And here is an ever widening and remunerative field for our students and graduates in mechanical engineering, with suitable positions as stepping stones all along the line and at its best during the students' vacation season. Few of them are taking advantage of the opportunity. The positions are filled mostly by men who have graduated from a threshing engine in one season; many have to be trained on the work without previous experience. As a matter of fact these latter men are usually the most satisfactory for they come admitting their inexperience and ready to learn, are usually very careful, and while ambitious for advaancement, are more willing to earn it by strict attention to duty. But their lack of technical education is so serious a handicap that they can rarely reach the higher ground and are unable to render themselves as useful to their employers as they otherwise might.

It is seldom that a road outfit is found under the charge of a first-class practical mechanic or engineer and yet nowhere are his services more urgently needed. The man in charge of all such outfits, whether owned by municipalities or by contractors, should be first of all a manager of men, and after that, a first-class machinist, and lastly a practical road builder. Others may arrange these essential requirements differently; all will agree about the first requirement being the ability to handle his men. I maintain that it is easier for the machinist to acquire a thorough knowledge of practical road building than for the road builder to acquire a thorough knowledge of the machinery he is required to use. Without that knowledge he is only half efficient and is always at the mercy of and dependent upon his various machine men, his lack of such knowledge detracting from his prestige not only with the machine men themselves but with the other men as well. Only a large development of the first quality has saved many a superintendent and engineer in many a difficulty where the necessary knowledge of his machinery would never have allowed it to develop.

Ordinarily a road outfit will be working at some distance from

any machine shop where repairs can be readily obtained. The building season is short at the best, and delays for machinery repairs very expensive. The superintendent who can detect and remedy faults before they become dangerous and who can repair on the ground the ordinary breaks, is able to keep his plant working a much larger percentage of the possible working time and save a larger proportion of maintenance and depreciation charges than the superintendent who lacks the thorough knowledge of his machinery. He is able to decide intelligently and at once the numberless questions which are always arising in connection with the proper and economical operation of the different machines.

To the college student in mechanical engineering the highway work should offer a strong appeal. It is at its best when he is free on his summer vacation. It takes him out into the clean pure fresh country air; the hours are regular; the board wholesome; the remuneration fairly high and the work varied but not arduous. To the man who has spent a couple of vacations on the work, has had some shop practice and has the ability to handle men, there are abundant openings at really good salaries. There is no standard scale of wages in this country, but a fair average would probably be from $1.50 to $2.00 per day and board running a stationary engine and rock crusher and from $2.00 to $3.00 operating a road roller or tractor. The man who has filled these positions, knows his road building, and can take charge of a complete outfit, is worth from $125.00 and expenses per month up, to any contractor or municipality and with work practically all year, the winter months being spent mostly in thoroughly overhauling all the plant which should commence each season in first-class condition.

C. A. Chilver, '04, is Sec-Treas. of C. A. Chilver Co., Limited, Builders' Supplies, Walkerville, Ont.

J. J. Hanna, B.A.Sc., '14, is on the staff of the city engineer, Calgary, Alta.

W. G. Millar, B.A.Sc., '14, is with P. H. Secord & Sons, Limited, General Contractors, on the erection of the new post-office at Newmarket, Ont.

(Capt.) N. C. Sherman, '10, is with Militia and Defence, Canada, at the ordnance office, Esquimalt, B.C.

R. C. Purser, B.A.Sc., '06, has been engaged on D. L. S. work in the West for the past three years.

J. L. Rannie, B.A.Sc., '07, has since January, 1913, been with the International Joint Commission in charge of topographic surveys, made under the Lake of the Woods reference. Mr. Rannie is now in the West in connection with this work.

W. A. Cowan, '04, of 137 Pleasant St., Halifax, is resident engineer for the Halifax Ocean Terminals Railway.

C. W. B. Richardson, B.A.Sc., '07, is at the Ottawa office of the Dominion Bridge Company, Limited.

EXAMINATION RESULTS, 1914

The following are the results of the examinations held in 1914. Candidates whose names are followed by brackets must pass supplemental examinations in the subjects indicated.

SCHOLARSHIPS

The Boiler Inspection and Insurance Company's scholarship for general proficiency in the third year mechanical engineering has been awarded to Mr. C. G. Davey.

M.A.Sc. DEGREE

W. C. Murdie received the degree M.A.Sc. His subject was "Stereophotogrammetry Applied to Surveying." Mr. Murdie is the first candidate to receive this new degree.

FIRST YEAR

Civil Engineering.

Honors—A. E. Berry, W. A. Bishop, R. S. C. Bothwell, G. A. H. Burn, F. C. Christie, H. F. Coon, R. A. Crysler, W. P. Dale, F. L. Eardley-Wilmot, J. A. Fraser, R. R. Hawkey, U. C. Holland, C. A. Hughes, W. H. Hunter, R. W. Hurlburt, R. E. Jones, H. L. Longworthy, R. C. Manning, G. A. McEwen, J. R. McLean, F. L. Mitchell, E. L. Moorhouse, H. R. Nicholson, A. F. Norris, H. A. Parr, G. P. Pearson, C. L. Pool, W. O. Proctor, C. M. Purchas, L. R. Shoebottom, G. E. Stephenson, B. Thompson, C. E. Tilston, F. M. Waddle, G. E. Wait, R. S. Warwick. G. A. Whately, G. Wood.

Pass—W. H. Aggett (trig., elem. chem.), O. V. Ball (elem. Chem.), C. A. Bishop (surveying), K. H. Chamberlain, E. H. Corman (trig., elem. chem.), E. R. Defoe, F. C. Darch (trig.), H. L. Dowling, E. B. Dustan (trig.), J. R. Gilley, T. S. Glover, D. S. Graham, K. W. Jamieson (trig., elem. chem.), E. W. Johnston, W. R. Kay, W. J. LeClair (algebra, anal. geom.), H. J. Legate (elem. chem.), J. A. Macdonald, R. Manzer, G. A. McClintock, W. H. Nixon, T. L. Ryan, (elem. chem.), G. H. Sohn (alg., trig.), C. W. G. Stevenson (alg., trig.), R. D. Taylor, A. P. Thomson (trig.), G. A. Webb, L. E. Willmott (alg., trig.).

Mining Engineering.

Honors—E. R. Gilley, H. L. McClelland, J. E. Sharman.

Pass—E. A. Howes (algebra).

Mechanical Engineering.

Honors—E. Bell, G. E. Booth, M. A. Snider.

Pass—S. B. Bingham (French, algebra), H. O. Dobbin (anal. geom.), A. B. Harris, M. G. Henderson, V. E. Ives (alg., trig), S. G. McCandlish (anal. geom.), P. E. McIlhargey, G. R. Sinclair (alg., anal. geom.), C. E. Tindale, O. D. Vaughan (alg.).

Architecture

Honors—E. W. Haldenby, A. S. Mathers, H. R. Watson.

Pass—J. Banigan (alg., anal. geom.), F. R. Gibson (anal. geom., accounts), A. G. Hume (alg., elem. chem.), C. C. Thompson (trig.).

Analytical and Applied Chemistry.

Honors—J. V. Dickson.

Pass—O. G. Lawson, A. P. Maclean (accounts), E. J. Tyrrell (alg., anal. geom.).

Chemical Engineering.

Honors—J. R. Belton.

Pass—A. B. Honeywell (magnetism and electricity, electric circuits), A. G. Knight (mag. and elec.).

Electrical Engineering.

Honors—N. Burwash, C. R. Catherwood, C. E. Harrop, C. Hewson, R. D. Huestis, G. F. Hutchison, F. C. Mayberry, W. J. Nichol, W. A. R. Offerhaus, R. D. Ratz, W. F. Secord, O. W. Titus, A. A. Tufford, J. S. M. Wallace, I. W. Webb.

Pass—W. B. Andrew (elec. cir.), J. G. Ballinger (elec. and mag., elec. cir.), R. A. Barbour (anal. geom., elec. cir.), W. R. Bauer, F. M. Bryans, S. W. Bumstead (trig.), C. E. Burton (elem. chem.), E. S. Byers, J. C. Colleran (alg.), P. A. Durbrow, R. T. Eyre (alg.), D. W. Ferrier, J. I. Gram (alg., anal. geom.), A. F. Hanley (alg., anal. geom.), D. M. Morgan, H. A. Tuttle, J. W. Ward, F. A. McKinley (alg., anal. geom.).

SECOND YEAR

Civil Engineering.

Honors—T. E. Armstrong, H. A. Babcock, L. F. Barnes, C. A. Doherty, J. H. Eastwood, K. B. Jackson, W. B. Mitchell, E. A. O'Callaghan, J. E. Pringle, S. R. Ross, W. B. Scott, R. L. Seaborne, R. L. Sievewright, R. E. Williams.

Pass—E. B. Allan (hydrostatics), R. R. Brown (spher. trig., org. chem.), E. Crosby, R. S. Dale (calculus), G. R. Dashwood, R. W. Downie (org. chem.), C. W. Edmonds, L. F. Gaboury (calculus), C. E. Gage (calculus, first year trig.), D. B. Gardner, G. D. Hagarty (hydrostatics), G. C. Hagedorn (mineralogy), G. W. Harron, J. R. Kirby, R. W. Kirby, L. A. Lee, O. Margison, F. J. Matthews (org. chem.), F. T. McPherson (calculus, org. chem.), A. R. Mendizabel (org. chem.), H. B. Norwich, V. R. Pfrimner (cal., org. chem.), W. W. Ritchie, H. C. Rose (spher. trig., hydrostatics), C. E. Smith (calculus, hydrostatics), C. Smythe (org. chem.), G. B. Snow (trig., spher. trig), R. M. Speirs (surveying, money), W. H. Stark (optics, org. chem.), F. S. Storms (money), G. S. Stratford (cal., optics), J. A. Sureda, M. S. Taylor (surveying, org. chem.), J. E. Tremayne (money), R. C. Ward (hydro.), A. B. Whaley, C. H. Wheelock, F. C. Wilson (chem. lab., spher. trig.), R. M. Hare (spher, trig., first year trig.).

Mining Engineering.

Honors—B. A. McCrodan.

Pass—C. E. Macdonald (calculus), F. W. Norton (elem. chem., mineralogy lab.).

Mechanical Engineering.

Honors—M. W. Keefer, J. C. Newcombe, J. P. Russell, H. A. Washington, J. M. Watson, L. L. Youell.

Pass—H. E. Bruels, J. N. Cunningham, L. Delisle (calculus, electricity), R. A. Macdonald (org. chem., money), F. S. Merry (steam engines, electricity), J. A. N. Ormsby (calculus, org. chem.), R. W. Kirn (aeg.), S. W. Ross (cal, hydrostatics).

Architecture.

Honors—R. T. C. Hoidge, L. Husband, W. S. Kidd.

Pass—F. H. Marani (accounts, hydro-statics), T. W. McLellan (aeg.), G. W. Schwartz, P. L. Stevens (money), F. A. Swinnerton (hydro., money), R. Tyerwhitt (cal., money), D. M. Waters, W. S. Wilson (calculus), J. L. Skinner (calculus, money).

Analytical and Applied Chemistry.

Honors—W. G. Birrell, F. W. Ward.

Pass—N. B. Brown (optics, physical chem.).

Chemical Engineering.

Honors—C. C. Anderson, D. Boyd, C. E. Oliver.

Pass—S. J. Krug (phys., chem.), W. H. O'Reilly (phys. chem., elec. and mag.).

Electrical Engineering.

Honors—J. B. Chapman, S. K. Cheney, L. G. Dande, T. A. Daniel, G. E. Nott, J. S. Panter, R. M. Thomas, A. R. Wells, H. S. Wepp, J. S. Wilson.

Pass—F. C. W. Ball (calculus, optics), F. W. Booth, K. M. Cumming, L. L. Cunningham, M. P. Fallis (steam engines, org. chem.), R. L. Flegg (cal.), A. Fleming, R. A. Fraser, H. A. M. Grasett (calculus), E. G. Gurnett, S. J. Hubbert (elec., Eng. chem.), J. Kelleher (I. year trig., dynamics), G. F. King, H. B. Little (hydrostatics), T. R. Manning (elec.), W. B. Pater (calculus, elec.), W. A. Smelser (cal., money), A. E. Widdicombe.

Metallurgical Engineering.

Honors—O. H. Hugill.

THIRD YEAR

Civil Engineering.

Honors—P. Bennett, G. G. Blackstock, E. D. Brouse, L. R. Brown, F. M. Buchanan, J. D. Cook, A. B. Crealock, W. R. Da Costa, E. V. Deverall, W. L. Dickson, G. A. Downey, A. C. Evans, J. W. H. Ford, W. J. Fulton, W. R. Fraser, W. G. French, E. R. Grange, C. E. Hogarth, C. W. H. Jackson, G. W. F. Johnston, R. E. Laidlaw, G. J. Lamb, W. E. Longworthy, C. T. Lount, C. R. McCort, J. P. Macdonald, K. D. Macdonald, D. F. McGugan, W. H. Meitz, G. Mitchell, H. S. Nicklin, C. F. Porter, J. E. Porter, W. E. Raley, G. Rankin, A. A. Richardson, H. M. Rowe, E. H. Scott, R. G. Scott, C. N. Simpson, L. P. Vezina, F. E. Weir, C. W. West, J. N. Williams.

Pass—L. S. Adlard (geology), W. W. Code, A. C. Anderson (field work, surveying), G. A. Arksey, F. D. Austin (surveying, astronomy), F. N. D. Carmichael (th. of structs., hydraulics), R. M. Cockburn (photography), C. P. Cottn (th. of Structs.), N. H. Daniel, H. S. Falconer (des. geom., surveying), R. D. Galbraith, C. N. Geale (th. of structs., hydraulics), G. A. Gooderham (th. of structs., geology), E. D. Gray (th. of structs), G. S. Gray (th. of structs., hydraulics), R. W. Harris (surveying, th. of structs.), C. Hayward, E. H. Jupp, W. E. Lockhart (hydraulics), R. G. Lye, H. E. Macpherson, G. L. Magann (hydraulics), W. R. McCaffrey, E. V. McKague, F. L. Mills, J. T. Mogan (th. of structs., geology), B. M. Morris (surveying, ast. and geod.), M. A. Neilson, E. B. O'Connor (calculus), P. L. Pearce, H. M. Peck, S. M. Peterkin, C. C. Rance (ast. and geod., th. of structs.), W. B. Redmond (ast. and geod., hydraulics), J. T. Rose (surveying, th. of structs.), J. H. Shaw, J. S. Sheehy, R. A. Steven (ast. and geod., hydraulics), D. H. Storms, L. B. Tillson, J. A. Tom (th. of structs), J. C. Wilson, H. A. Wood.

Mining Engineering.

Honors—M. B. Glazier, W. T. Hall, J. E. Hanlon, L. T. Higgins, I. M. Macdonnell, J. B. Stitt, W. S. Wilcock.

Pass—W. N. Allan, R. M. Arthur (mineralogy lab., th. of structs.), E. R. Emmerson (surveying, th. of structs.), M. S. Haas, R. D. Jones (metallurgy, ltd. cos.), F. L. mills (mining, French), J. M. Muir, J. Ross, J. E. C. Stroud.

Mechanical Engineering.

Honors—C. G. Davey, boiler inspection and insurance companies' scholarship for general proficiency; R. H. Lloyd, W. R. McGie, A. N. Payne, F. G. Reid, W. G. Shier, C. A. Smith.

Pass—A. S. Robertson, J. Gray, A. H. Smyth, (alt. current), J. D. Stone, H. C. Taylor (elect. lab., elect.), G. D. Tillson (th. of structs., hydraulics).

Architecture.

Honors—H. J. Burden, K. C. Burness, M. Denison, A. Morris.

Pass—R. W. Catto (calculus), J. J. Davidson (limited cos.), G. R. Edwards (th. of structs., calculus), T. S. Graham (limited cos.), H. A. Heaton, G. W. Rutter (des. geom., th. of structs.).

Analytic and Applied Chemistry.
Honors—H. Kohl, W. Morris, W. Uffelmann.
Pass—L. T. Watson (crystallography, metallurgy.)

Chemical Engineering.
Honors—J. E. Breithaupt.
Pass—L. G. Glass.

Electrical Engineering.
Honors—J. Diblee, W. H. R. Gould, G. Ironside, G. W. Lawrence, W. A. Steel, A. L. Ward.
Pass—W. V. Ball (thermo., elect. design,). T. R. Banbury, V. A. Beacock, A. L. Birrell (hydraulics, thermo.), W. H. Bonus (hydraulics, ltd. cos.), H. C. Budd (alt. current, elect. design), F. H. Chandler (elect. lab., ltd. cos.), G. P. Davidson (hydraulics, electricity), W. A. Dean (mech. of mach.), R. V. Elliott, G. E. Griffiths, T. P. Ireland, K. A. Jefferson (elec. lab., elec. des.), C. M. Jones, H. C. Karn (aeg.), C. R. Keys, E. T. Martin (electrochem.), E. M. Monteith (hydraulics), W. F. P. Purdy, A. C. Ross (elec. design), W. E. Russell (hydraulics, thermo.), W. M. Ryan (electricity, elec. design), A. G. Scott (mech. of mach., alt. current), N. F. Seymour (alt. current, electrochem.), A. N. Suhler, A. N. Taylor (hydraulics, elec. design), E. W. Savage.

FOURTH YEAR (B.A.Sc. Degree).

Civil Engineering.
Honors—F. C. Adsett, J. L. Alton, H. J. Bedard, J. M. Blyth, J. H. W. Bower, D. H. Campbell, J. J. Campbell, R. M. Christie, W. Cuthbertson, R. Dashwood, R. D. Davidson, F. W. Douglas, H. E. Eyres, O. M. Falls, J. L. Foreman, J. J. Hanna, L. T. Hayman, B. B. Hogarth, S. A. Hustwitt, R. P. Johnson, R. E. Lindsay, H. N. Macpherson, J. A. P. Marshall, R. C. McDonald, C. A. Meadows, F. C. Mechin, W. G. Millar, J. S. Mitchell, E. P. Muntz, C. Noecker, J. B. Nicholson, R. G. Patterson, C. V. Perry, H. L. Sheppard, B. N. Simpson, J. B. Skaith, N. L. Somers, C. N. Temes, G. E. Treloar, F. T. Van Dyke, H. G. Waddell, H. W. Wagner, H. D. M. Wallace.

Pass—E. M. Abendana (th. of structs.), E. L. Bedard, J. T. Belcher, S. S. Bennett (th. of structs.), P. V. Binns, J. W. Crashley (st. of mats., lab., ast. and geod.), G. F. Dalton, J. A. Elliott, G. O. Fleming, C. H. R. Fuller, R. W. Gouinlock (thermo.), J. H. Hawes, J. Kay (th. of structs.), J. A. Knight, W. A. Maclachlan, S. B. McGill (thesis), A. S. Miller, J. R. Montague, C. J. Mullins (thermo., electricity), J. A. Owens, A. H. Parker (thesis, st. of mats., lab.), C. W. Pennington (electricity, th. of structs.), P. H. Raney, R. H. Rice (hydraulics general), F. S. Rutherford, N. E. D. Sheppard, S. Shupe, C. E. Sinclair (th. of structs.), H. M. Smith, I. R. Strome, J. A. Tilston, R. L. Whitley, H. P. Wilson.

Mining Engineering.
Honors—H. R. Banks, S. D. Ellis, J. R. Gill, S. A. Lang, W. A. Macdonald, R. W. Young, H. J. MacKenzie.
Pass—F. C. Andrews, R. T. Carlyle, J. M. Carter, E. V. Chambers, J. S. Fleming (petrography lab., ore dressing), W. Hutchings (mineralogy, electrochemistry), P. W. Meahan (mineralogy), G. M. Smyth (power), J. S. Taylor.

Mechanical Engineering.
Honors—H. H. Brown, H. M. Campbell, E. D. W. Courtice, H. F. Elliott, W. H. Hall, G. H. Hally, H. W. Maxwell, J. G. Scott, S. G. Tackaberry, E. H. Tennant, M. F. Verity.
Pass—K. M. Clipsham, R. D. Delamere (const. notes), H. S. Kerby, J. A. Kerr, B. MacKendrick (thesis, th. of structs.), A. H. MacQuarrie, P. H. McQueen (th. of structs.).

Architecture.
Honors—J. M. Robertson, W. C. Skinner, A. C. Wilson.
Pass—E. E. H. Hugli, N. G. Keefer (struct. design).

Analytical and Applied Chemistry.

Honors—J. G. G. Frost, O. G. Lye, W. E. Phillips, G. E. Smith.
Pass—A. R. Bonham.

Chemical Engineering.

Honors—C. N. Candee, W. E. Milligan, A. E. Wigle.
Pass—D. Morrison, A. W. Sime (org. chem., hydraulics), E. A. Twidale.

Electrical Engineering.

Honors—W. D. Brown, A. W. Crawford, H. J. Franklin, E. I. Gill, A. S. Jannati, J. I. Kamman, C. W. Latimer, A. M. Mackenzie, R. C. Matthews, P. H. Hills, C. L. Nicholson, J. D. Peart, G. O. Philp, W. M. Philp, F. M. Servos, E. C. R. Stoneman, W. S. Tull, J. A. H. Wigle.

Pass—C. E. Armer, H. A. Campbell (electricity, first and second papers), C. E. B. Corbould, H. C. Edwards (electricity 2), D. G. Ferguson, C. I. Grierson, G. E. Kewin, N. H. Lorimer (electrical lab., electricity 1), J. A. Marshall, D. L. McLaren, A. S. Robertson, H. D. Rothwell, R. O. Standing.

Degree of Master of Applied Science (M.A.Sc.), W. C. Murdie.

Supplemental Examinations Passed.

First year subjects:—Accounts—R. R. Brown, F. S. Storms, F. W. Norton, K. M. Cumming. Field work—R. R. Brown. Trigonometry—L. Delisle, G. F. King, R. T. Park, H. Ramsay. Algebra—H. C. Rose, G. Hanmer, S. J. Hubbert, W. B. Paterson, R. W. Catto. Dynamics—H. S. Smith, R. M. Hare, F. C. Wilson, C. K. Macpherson. French—A. F. Pym. Elementary chemistry—F. S. Storms, F. C. Wilson, G. Hanmer, L. Delisle. Analytical geometry—K. A. Jefferson. Electricity and magnetism—R. L. Flegg, L. Levesque.

Second year subjects:—Spherical trigonometry—A. C. Anderson, R. W. Harris, W. E. Rockhart. Astronomy—R. G. Lye, W. H. Meitz. Calculus—F. D. Austin, E. V. Deverall, W. E. Lockhart, E. V. McKague, D. E. Murphy, L. B. Tillson, R. D. Jones, H. J. Burden, H. C. Taylor, H. C. Budd, G. P. Davidson, E. M. Monteith. Steam engines—E. T. Martin. Organic chemistry—W. H. Bonus, W. W. Code, J. A. Tom, R. G. Lye. Optics—W. H. Bonus, C. Hayward, G. Rankin, L. P. Vezina. Electricity—H. C. Taylor, L. W. Railton, M. E. Nasmith, E. A. Jamieson. Metallurgy—L. T. Watson, F. N. D. Carmichael. Hydrostatics—W. N. Allan, G. R. Edwards. Dynamics—F. D. Austin. Inorganic chemistry—F. N. D. Carmichael, R. M. Arthur, E. R. Emmerson, R. D. Jones. Strength of materials—G. A. Gooderham, E. D. Gray, G. J. Lamb. Mineralogy laboratory—G. Rankin, C. W. West, J. Ross, G. A. Gooderham, G. S. Gray. Money—G. S. Gray. Descriptive geometry—R. W. Harris. Surveying—P. L. Pearce. Practical chemistry—H. M. Rowe, J. S. McIntyre. Geology—W. Hutchings.

Third year subjects:—Mechanics of machinery—W. M. Philp. Thermodynamics—A. H. McQuarrie, J. S. McIntyre, C. E. B. Corbould. Hydraulics—A. H. MacQuarrie, J. A. Marshall, P. V. Binns, J. W. Crashley, J. B. Nicholson, N. E. D. Sheppard, J. A. Tilston, W. Hutchings. Alternating current—H. A. Campbell, C. E. B. Corbould, Electricity—W. H. Hall, B. MacKendrick. F. C. Andrews. Electro-chemistry—H. D. Rothwell. Surveying—E. M. Abendana. Theory of structures—J. B. Nicholson, R. H. Rice, H. E. D. Sheppard, H. M. Smith, N. G. Keefer, G. F. Dalton, A. S. Miller, C. E. Sinclair. Astronomy and geodesy—J. R. Montague. Metallurgy—J. S. Fleming. Geology—G. E. Sinclair, J. M. Blyth, J. B. Skaith, H. M. Smith. Petrography—J. M. Carter. Ore dressing—F. C. Andrews, J. M. Carter, H. J. MacKenzie. Mining—D. S. Halford, J. G. Shepley. Analytical chemistry—J. S. Fleming, H. J. MacKenzie, D. Morrison. Organic chemistry—D. Morrison. Engineering chemistry—S. A. Hustwitt. Biology—E. L. Bedard. Assay laboratory—D. S. Halford, J. G. Shepley. Modelling—J. M. Robertson. Photography—J. A. Tilston.

Fourth year subjects—Geology—G. M. Carrie. Thermodynamics—A. M. German. Hydraulic laboratory—A. M. German. Metallurgy laboratory—C. A. Bell, W. H. Garnham. Assay laboratory—W. B. Caldwell. Chemical

laboratory—H. A. Clark. Mining—W. B. Caldwell. Electricity—G. R. Johnson. Theory of structures—H. D. Davison.

Supplemental Examinations to be Taken

First year subjects—Algebra—H. D. Wallace, F. L. Mills, H. S. Smith. Electrical laboratory—R. A. Cross. Trigonometry—R. A. Cross, M. Johnston, S. R. Seaman, D. P. Barr. Accounts—C. K. Hoag. Electricity and magnetism—M. Johnston, R. H. Wilson. Elementary chemistry—A. F. Pym, L. Levesque. Dynamics—H. Reid.

Second year subjects—Organic chemistry—J. M. Carswell. Calculus—W. W. Code. Optical laboratory—M. Gurofsky. Alternating current—W. E. Longworthy. French—F. L. Mills.

C. A. Meadows, '14, sailed for England on May 14, for a couple of months holiday on the continent.

Gower Markle, '09, is with the Sewers Department, City Hall, Toronto.

C. A. Webster, B.A.Sc., '13, is with Sheldon's Limited, Galt, manufacturers of heating and ventilating equipment.

W. M. Philp, B.A.Sc., '14, is employed as draftsman for Turnbull Elevator Mfg. Co., Toronto.

W. P. Murray, B.A.Sc., '08, is at present at Lytton, B. C., for the Dominion Bridge Co., on engineering work in connection with several bridges now being constructed by that company on the line of the Canadian Northern Pacific Railway.

R. J. Marshall, B.A.Sc., '08, has recently been appointed town engineer of Trenton, Ont.

H. P. Wilson, B.A.Sc., '14, is with Elias Rogers Co. as engineer in charge of the construction of their new coal yards and sheds.

In mentioning the Past-Presidents who attended the twelfth annual banquet of the University of Toronto Club of New York in the March issue, the name of Mr. H. F. Ballantyne was unfortunately omitted. Mr. Ballantyne is one of the very best workers for the club and has been elected Secretary-Treasurer, which position he filled a few years ago. At the Twelfth Annual Meeting of the club, the following officers were elected.

President: L. L. Brown, '95; Vice Presidents: W. A. Merkley M.D.; H. V. Serson, '05; John S. Thompson, Arts; Secretary-Treasurer: Henry F. Ballantyne, B.A.Sc., '93; Membership Committee (to serve three years): H. P. Rust, B.A.Sc., '01.

B. B. Tucker, B.A.Sc., '04, is with the Rapids Power Co., Limited, Morrisburg, Ont.

A. U. Sanderson, B.A.Sc., '09, is with the Water Supply Section, Department of Works, Toronto.

W. F. Wright is in the motor sales department, Canadian General Electric Co., Limited, Toronto.

Russell Young, '08, has for the past two years been electrical superintendent of construction for the B. C. Electric Ry. Co. in charge of all sub-station construction work.

H. Goodridge, '10, is resident engineer on sidewalks for the city of Edmonton.

APPLIED SCIENCE

INCORPORATED WITH

Transactions of the University of Toronto Engineering Society

DEVOTED TO THE INTERESTS OF ENGINEERING, ARCHITECTURE AND APPLIED CHEMISTRY AT THE UNIVERSITY OF TORONTO

Published every month in the year by the University of Toronto Engineering Society

Subscription Rates

Per year, in advance	$2.00
Single copies	.20

Advertising rates on application.

Address all communications:

Applied Science,
Engineering Bldg., University of Toronto,
Toronto, Ont.

EDITORIAL

CLASS '09 MEETING

On Monday, May 18th, the Toronto members of Class '09 held a meeting at the Strollers' Club on Yonge Street, where dinner was served at 6.15 p.m. Mr. J. A. M. Williams of A. E. Ames Co. gave a very interesting talk on "Finance" after which he answered many questions which arose out of the discussion which followed. Messrs. Williams, Turnbull, Irwin and Workman were appointed to secure a speaker for the next meeting and to draft a constitution to govern these meetings, which will be financed wholly by the members af the class who attend and not by the class organi-

zation, although all members of the class are considered members of the club now being formed. It is desired that any '09 men, who are not receiving notice of these meetings, will send their address to the class secretary, G. R. Workman, 1 Wood St., Toronto.

BOOK REVIEW

Canadian Patent Law and Practice.—By Harold Fisher, B.A., L.L.B., and Russel S. Smart, B.A., M.E., with an Appendix on Canadian Patent Office Practice by W. J. Lynch, I.S.O.; published by Canada Law Book Company, Limited, Toronto, 478-xxxii pp.; 6 in. x 9 in. half leather binding; price $7.50.

This book, while it was meant primarily for patent attorneys and solicitors, affords a great deal of information of interest and value to engineers who have occasion to investigate patent claims or regulations pertaining to them.

Considerable space has been devoted to cases of infringement of a patent, and practice in infringement cases. A chapter is devoted to general regulations governing the application for and granting of patents in foreign countries. In fact, the entire subject of patent law has been very thoroughly treated by the authors and has been so presented as to be readily appreciated by any person who is at all interested in the laws and customs relating to patents.

The work is divided into 20 chapters and is supplemented by an appendix by W. J. Lynch, Chief of the Canadian Patent Office, in which are discussed in detail the essentials for guidance in preparing and prosecuting applications and other proceedings relating to patents. The volume also contains copies of standard forms for petitions, specifications, assignments, disclaimers, etc.

Note.—Mr. Smart graduated from the "School" in Mechanical Engineering in 1904.

"SCHOOL" MEN IN BRITISH COLUMBIA

The annual report of the Minister of Lands for the Province of British Columbia for the year ending 31st December, 1913, contains reports by several "School" graduates on work which they had been doing for that department of the government during the year. A perusal of these reports impresses the reader with the magnitude of the undeveloped resources of that province and we cannot but realize that the "School" is doing a very great deal toward the development of those resources, so that they will add to the coffers of the country.

On page 114 is the Water-Power Investigation Progress Report by the Engineer in Charge, Mr. A. V. White, M.E., '92, of the Commission of Conservation, Ottawa. It is followed by the report of R. G. Swan, B.A.Sc., '09, chief engineer, of the British Columbia Hydrographic Survey. Other reports in the Water-Power Branch are submitted by the following District Engineers, E. A. Jamieson, '10, W. Chester Smith, B.A.Sc., '10, and A. W. Campbell, B.A.Sc., '06. Mr. Jamieson's report relates to work done on the Capilano

River and watershed and the power possibilities of the Coquihalla River near Hope; Mr. Smith's report relates to watersheds available for Greater Vancouver water supply and that of Mr. Campbell to work done in the Quesnel and Barkerville Water Districts.

The section of the book relating to the Survey Branch contains reports by J. E. Umbach, '03, chief draughtsman, Lands Dept., Department of Interior; T. A. McElhanney, B.A.Sc., '10, on surveys in vicinity of Nazko River; D. O. Wing, '08, on surveys in Groundhog District; S. M. Johnson, B.A.Sc., '94, on Anarchist Mountain surveys; J. A. Walker, B.A.Sc., '08, on surveys on the South Fork of Fraser River, Cariboo District, and J. E. Ross, '88, on surveys made on the upper portion of Deadman River and its tributaries.

GABY—MACBETH

On Wednesday, May 20, Mr. F. A. Gaby B.A.Sc., '03, Chief Engineer, Hydro-Electric Power Commission, Toronto, was united in marriage to Miss Catharine Florence MacBeth, 60 Brock Ave., Toronto. Mr. and Mrs. Gaby have gone on a fortnight's motor trip through the Berkshire Hills. Applied Science extends congratulations.

GOODEVE—DAVIDSON

The marriage of Vincent S. Goodeve of class '10, to Miss Grace Davidson of Dickinson's Landing, Ont., took place at Nelson, B.C., on Saturday, May 9th, the ceremony being performed by Rev. R. J. McIntyre.

Mr. and Mrs. Goodeve will reside in Phoenix, B.C., where Mr. Goodeve is employed by the South Kootenay Water Power Co. We extend to them our best wishes.

W. Snaith, '07, is at present on a business trip in the California oilfields for the Thor Iron Works Limited.

L. T. Rutledge, B.A.Sc., '09, is manager of Excelsior Electric Mfg. Co., 419½-421 Queen St. W., Toronto.

K. M. Van Allen, B.A.Sc., '10, is engaged in fruit-farming at Summerland, B.C.

W. P. Brereton, B.A.Sc., '01, has recently been appointed city engineer of Winnipeg, Man.

Walter J. Francis, C.E., '93, accepted the invitations of the Ottawa and Calgary branches of the Canadian Society of Civil Engineers to address them on April 2, and April 9th, respectively. The subject of address in both cases was, "The Engineer and the Public." These addresses were of the high calibre characteristic of Mr. Francis' several previous lectures relating to the Engineer, and were exceedingly well received.

Greenwood, W. K., '04, is engineer for Orillia, Ont., Water, Light and Power Commission.

Guernsey, F. W., '95, is engineer for the Consolidated Mining & Smelting Co., at Trail, B.C.

Gulley, C. L., '08, is with the Northern Electric & Mfg., Co., Limited, Toronto, as sales engineer.

Gunn, W. W., '09, is in the Toronto office of the Dominion Bridge Co.

Gurney, W. C., '96, is vice-president of the Gurney Foundry Co., Limited, Toronto.

Guest, W. S., '00, is Lecturer in Electrical Engineering, University of Toronto.

Guy, E., '99, is in Toronto at present. His address is 541 Euclid Ave.

H

Hackner, J. W., '08, whose home is in Sandford, Ont., is assistant engineer for the Department of Public Works, Ontario.

Hadcock, J. P., '13, was in the test department of the Canadian General Electric Co., Peterborough, when last heard from.

Hagarty, R. E. W., '07, is manager of the Vancouver office of Western Pavers, Ltd.

Haight, H. V., '96, is chief engineer of the Canadian Ingersoll Rand Co., Sherbrooke, Que.

Hall, H. G., '11, is assistant superintendent, Woodstock Water & Light system, Woodstock, Ont.

Hall, K., '07, is assistant engineer C.N.R. Peace River Branch. Address mail to A. T. Fraser, district engineer C.N. Railway, C.N.R. depot, Edmonton, Alta.

Hamer, A. T. E., '01, is on the engineering staff of the Canadian Northern Ontario Railway, and is resident at Cochrane, Ont.

Hamilton, J. F., '03, is a member of the firm of Hamilton & Young, Dominion Land Surveyors and Civil Engineers, Lethbridge, Alta.

Hamilton, C. B., '06, is owner and general manager of the Hamilton Gear & Machine Co., Toronto, Ont.

Hamilton, C. T., '07, is in Vancouver B.C., residing at 1414 Haro St., and is a member of the city engineer's staff.

Hamilton, G. M., '11, is on the engineering staff of the Welland Ship Canal. His addre s is Box 57, Humberstone, Ont.

Hanley, S. C., '93, used to be with the Midland (Ont.) Engine Works Co. We do not know his present location or employment.

Hanes, G. S., '03, is mayor of North Vancouver, B.C.

Hanning, G. F., '89, whose home is in Toronto, is divisional engineer for the Canadian Northern Railway at St. Eustache, Que.

Hara, L. D., '04, is in St. Catharines, Ont., as superintending engineer on the Welland Canal construction.

Hare, R. A., '07, is in charge of the test department of the Canadian Crocker Wheel Co. at St. Catharines, Ont.

Harcourt, F. Y., '03, is assistant engineer, Department of Public Works for Ontario, at Port Arthur, Ont.

Harcourt, H. E., '11, is resident engineer, sewer department, city of Toronto. He is also secretary-treasurer for J. H. Tromanhauser Co. Ltd, engineers, architects and contractors, Temple Building, Toronto.

Hare, W. A., '99, is president and managing director of the Hare Engineering Co., Limited, Toronto.

Harkness, A. H., '95, is senior member of the firm of Harkness & Oxley, consulting structural engineers, Toronto, Ont.

Harkness, A. L., '06, was in the engineering offices of the St. Lawrence Bridge Co., Montreal, Que., when last heard from.

Harper, C. J., '09, is in Collingwood, Ont., at present.

Harris, C. J., '04, resides in Brantford, Ont., in the employ of the Brantford Screw Co.

Harris, J. H., '10, is superintendent for W. Harris & Co., manufacturers of glue, fertilizers, etc., Toronto, Ont.

Harris, F. K., '09, is with W. Harris & Co., Toronto.

Harris, R. C., was resident engineer for C. P. Ry. at Medicine Hat, Alta. We are not certain of his present address.

Harrison, R. L., '06, is engineer in charge of the Toronto Eastern Railway, and resides in Oshawa, Ont.

Harrison, F. W., '05, is engineer for H. D. Best Co., builders, New York.

Harrison, E., '06, is senior member of the firm of Harrison & Ponton, engineers and surveyors, Calgary, Alta.

Harston, R. G. L., '09, is superin-

tendent for W. S. Tomlinson & Co., contractors, Toronto, Ont.

Hartney, J. C., '06. We do not know his present address or occupation.

Harvey, C., '01, resides in Kelowna, B.C. He is consulting civil engineer and land surveyor.

Harvey, D. W., '09, is assistant engineer of railways, department of works, Toronto.

Harvie, N. J., '10, whose home is in Orillia, Ont., has no record of professional employment with us.

Hastings, M. B., '10, is sales engineer for A. H. Winter Joyner, Limited, electrical supplies, Toronto.

Haultain, H. E. T., '89, is Professor of Mining Engineering, University of Toronto. He also has an office as consulting engineer at 123 Bay St., Toronto.

Haviland, F. L., '08, is with the Hamilton Bridge Works Co., Hamilton, Ont., in the engineering department.

Hawley, H. A., '13.

Hay, C. O., '09, deceased, September 5, 1911.

Hayes, L. J., '03, is manager of the Niagara Falls (N.Y.) office of the Development and Funding Company.

Hayman, A. W., '13, is engaged in building construction at London, Ont.

Hearn, R. L., '13, is on the staff of the Hydro-Electric Power Commission, Toronto.

Heebner, M. B., '11, is at Pitt River, B.C., as engineer in charge of construction work for the Foundation Cement Co.

Helliwell, J. G., '10, is on the design of structural steel work with the Canadian Bridge Company at Walkerville, Ont.

Helson, F. J., '07, is division engineer for the Canadian Northern Ontario Railway, at Hobon, Ont.

Hemphill, W., '00, is superintendent of lines for the Cataract Power and Conduit Co., Buffalo, N.Y.

Hemphill, J., '09, is construction engineer for the mines department, Algoma Steel Corporation, with headquarters at Magpie Mine, Ont.

Henderson, E. E., '85, although we do not hear from him, we have no knowledge of any change from his old address, Henderson, Maine.

Hawley, H. A., '13, is with the Lewis Construction Co., Toronto.

Henderson, F. D., '03, resides in Ottawa, Ont. He is on the staff of the topographical surveys branch, Department of the Interior.

Henderson, J. F., '10, is resident engineer for Chipman & Power at Thorold, Ont.

Henderson, S. E. M., '00, is switchboard sales engineer for Canadian General Electric Co., Toronto, Ont.

Henderson, C. D., '08, is with the Canadian Bridge Company at Walkerville, Ont.

Hendry, M. C., '05, whose home is in Toronto, is with the Waterpower Branch, Department of the Interior, Ottawa.

Henry, J. A., '00, resides in Schenectady, N.Y. He is with the General Electric Company as designing engineer.

Henry, R. A., '13, formerly with the Dominion Bridge Co., Montreal, was at Barrie, Ont., when last heard from.

Henwood, C., '02, is secretary-treasurer of the Toronto office of Ross & Macdonald, engineers and architects, Montreal.

Herald, W. J., '94, who was with the Canada Foundry Company for some time has no address with us since then.

Hermon, E. B., '86, is in Vancouver, B.C., where he is in the employ of the Vancouver Power Co., as assistant chief engineer.

Heron, J. B., '04, is with the Canadian Northern Railway Co., at North Bay, Ont., as district engineer.

Hertzberg, C. S. L., '05, is a member of the firm of James, Loudon & Hertzberg, structural engineers, Toronto, Ont.

Hertzberg, H. F. H., is chief engineer for the Trussed Concrete Steel Co. of Canada, Limited, Walkerville, Ont.

Hett, S., '06, is locating engineer for the Hudson Bay Ry. We do not know his address.

Hewson, W. G., '05, is with the Hydro-Electric Power Commission of Ontario, Toronto Office, as assistant engineer.

Hewson, E. G., '08, division engineer of Ontario lines of the Grand Trunk Railway, resides in Toronto, Ont.

Hickling, F. G., '10, is in the engineering office of the Westinghouse Electric and Manufacturing Co. at East Pittsburg, Pa.

Hicks, W. A. B., '97, resides in Philadelphia, Pa.

Hill, E. M. M., '04, is in Edmonton, Alta., in the engineering department of the Canadian Northern Railway.

Hill, S. N., '04, is with the Topographical Surveys Branch, Department of the Interior, Ottawa, Can.

Hill, H. O., '07, is designing engineer for the Blaw Steel Construction Co., Pittsburg, Pa.

Hill, H. R., '11, is cost engineer for the Toronto Hydro-Electric system.

Hill, T. A., '13. His home is at Ninga, Manitoba.

Hillis, C. R., '96, whose home is in Toronto, is consulting engineer for the Canadian Westinghouse Co., of Hamilton.

Hinch, E. F., '10, is resident engineer at Port Credit, Ont., for the Toronto Power Company.

Hodgins, Geo. S., '81, is mechanical engineer, National Transcontinental Ry., Ottawa, Ont.

Hogarth, G., '09, is assistant engineer, Ontario Department of Public Works, Toronto.

Hogg, T. H., '07, is assistant hydraulic engineer for the Ontario Hydro-Electric Power Commission, and resides in Toronto.

Holcroft, H. S., '00, is in Toronto with the Canada Life Assurance Co.

Holden, O., '13, is with the Hydro-Electric Power Commission, Toronto, Ontario.

Holmes, A. E., '09, is in Montreal, Que., with the Canadian Westinghouse Co. as sales engineer.

Holmes, C. R., '09, is in Detroit, Mich., with the Electric Storage Battery Company.

Hookway, C. W., '06, is with the Canadian Allis Chalmers Co., in the Winnipeg office.

Hopkins, P. E., '10, is stationed at Porcupine, Ont., for the Ontario Bureau of Mines.

Hopkins, R. H., '06, is on the engineering staff of the University of Toronto, as lecturer in electrical engineering. He is also town engineer of Lindsay, Ont.

Horton, J. A., '03, was in Northern Ontario when last heard from, several years ago.

Hoshal, G. C., '09, is with the Hydro-Electric Power Commission, with headquarters at Niagara Falls, Ont.

Houston, R. S., '06, is assistant engineer with the Vulcan Iron Works, Winnipeg, Man.

Howard, J. T., '13, is on the staff in engineering at University of Toronto as demonstrator in drawing.

Howlett, T. F., '13, is in the West at present.

Huber, W., '06, is assistant to the chief engineer, Department of Public Works, Toronto.

Huether, D. J., '08. We do not know his address.

Huether, A. D., '08, is a member of the engineering staff of the city of Toronto, main drainage works.

Huff, A. J., '11, is in Edmonton, Alta., with the Huff Gravel Co., Limited.

Huffman, K., '11, whose home is in Toronto, is with Mackenzie, Mann & Co., construction department.

Hughes, C., '09, is location engineer for the St. John & Quebec Railway, with the Fredericton, N.B., office.

Hull, H. S., '95, was with the Cambria Steel Co. in their works at Johnstown, Pa., as structural engineer when last heard from.

Hull, A. H., '06, is assistant electrical engineer in the Toronto office of the Ontario Hydro-Electric Power Commission.

Hunter, A. E., '09, has no address with us.

Hunter, A. N., '08, is with Geo. J. Beattie, electrical contractor, 72 Victoria St., Toronto.

Hutcheon, J., '90, is on the staff of the Department of Lands, Forests and Mines, Toronto.

Hutton, C. H., '07, formerly with the Dominion Power Co., of Hamilton, Ont., as electrical engineer, is now living in Toronto.

Hyatt, H., '11, is assistant engineer for P. Lyall & Sons Construction Co. Ltd., Toronto.